Resin bonding to wet substrate. II. Bonding to enamel

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In part I of this study, it was reported that high shear bond strengths to dentin were obtained by using a particular dentin-enamel bonding system on wet dentin. Because it would be difficult to dry the enamel without drying the dentin, an investigation was undertaken to determine if the treatment of enamel surfaces with various phosphoric acid concentrations would be successful on wet enamel using the same bonding system. It was discovered that the bond strengths to etched and wet enamel using a particular dentin-enamel bonding system were equal to or higher than bond strengths to etched and dry enamel. (Quintessence Int *1992;23:625–627.*)

In part I of this study,[1] it was reported that a dentinal bonding resin can successfully bond to a wet dentinal surface. It was shown that not only is it possible to adhere to the wet dentinal surface, but that optimal bond strengths are achieved when the dentinal surface is wet. This is attributable to the physical properties of acetone. The addition of acetone to water raises the vapor pressure of water so that some of it volatilizes away from the dentinal surface. The addition of acetone also causes the surface tension of water to be reduced.[2] Thus the acetone-resin primer mixture "chases" the water until an equilibrium is reached. It was speculated that the increased bond strengths are a result of deposition of the primer in intimate adaptation to the surface of the dentin and the tubule walls.

The data suggested that it is preferable to place the primer mixture on a wet dentinal surface. It would be particularly difficult, however, to dry the water rinse from the enamel without also drying the dentin. Therefore, if the enamel could also be bonded while wet, the overall procedure could be enormously simplified. The purpose of this report was to investigate the ability of the All-Etch/All-Bond dentin-enamel bonding system (Bisco Dental) to bond to wet enamel.

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Method and materials

Forty recently extracted human molars were employed in this study. They were free of obvious defects. The teeth were embedded in autopolymerizing acrylic resin in an aluminum ring. The teeth were ground on a model trimmer so that a uniform, flat enamel surface suitable for bonding was generated. The ground surfaces were standardized by wet sanding with 320-grit sandpaper. The teeth were then divided into four equal groups for surface treatment.

Group 1

The enamel surfaces in this group were treated with 37% phosphoric acid gel etchant for 15 seconds, rinsed, and dried. One drop of primer A and one drop of primer B of the All-Etch/All-Bond system were mixed together in a well and applied to the etched surface in four layers without drying between layers. The primer mixture remained undisturbed for 10 seconds and was then thoroughly air dried for 5 seconds. A thin layer of Bisco dentin-enamel bonding resin was applied to the primed surface and was light polymerized for 20 seconds. Composite resin cylinders made of Bisfil all-purpose composite resin were then bonded to the treated surface as previously described.[1]

Group 2

The enamel surfaces in this group were treated as they were in group 1, except that they were not dried after etching and rinsing. A wet facial tissue was wiped

Table 1 Mean shear bond strength (MPa)

Group	Mean	SD	CV*	N-K Grouping
1 (37% Etch, dry)	29.88	3.30	11.0%	
2 (37% Etch, wet)	32.61	4.50	13.8%	
4 (10% Etch, wet)	32.42	5.57	17.2%	
3 (10% Etch, dry)	25.97	3.26	12.6%	

* Coefficient of variation.

across the etched surface once to remove only the excess water. The enamel surface remained clearly wet. The mixture of primers A and B and the unfilled resin were applied as in group 1. Composite resin cylinders were bonded to the treated surfaces.

Group 3

The enamel surfaces in this group were treated with a 10% gel etchant (All-Etch Gel) for 30 seconds, thoroughly rinsed, and dried. Primers A and B and unfilled resin were applied as in group 1. Composite resin cylinders were bonded to the treated teeth.

Group 4

The enamel surfaces in this group were treated with 10% phosphoric acid gel etchant for 30 seconds and thoroughly rinsed. A wet facial tissue was wiped across the etched surface to remove only the excess water. The surface remained wet. Primers A and B and unfilled resin were applied as in group 2. Composite resin cylinders were bonded to the treated enamel surfaces.

The bonded specimens were placed into water at 37 °C for 24 hours. They were then placed on an Instron universal testing machine (Instron Corp) and tested for shear bond strength at a crosshead speed of 5 mm/min.

Results

The mean bond strength of each group is listed in Table 1. The grouping that resulted from use of the Newman-Keuls analysis is also indicated.

Discussion

The data indicated that enamel may be successfully etched with concentrations other than the usual 37% etchant. The results also show that it is possible to bond resin to wet enamel with the described system. The choice of 10% phosphoric acid is the result of unpublished data that suggested 10% phosphoric acid can successfully etch enamel and dentin at the same time and result in good bond strength values for both substrates.

There is historical precedent for the use of lower phosphoric acid concentrations. Gwinnett[3] noted that 10% phosphoric acid and 50% phosphoric acid can produce the same depth of etch in enamel. Soetopo et al[4] reported that, after a 1-minute etch, phosphoric acid concentrations of 7.5% to 30% produce the maximal tensile bond strengths. Gottlieb et al[5] reported, after examining a range of phosphoric acid concentrations for purposes of etching enamel, that 10% phosphoric acid resulted in the highest mean tensile bond strength. This bond strength was not, however, significantly higher than most of the other concentrations examined. Barkmeier et al[6] examined the bond strengths effected by the use of 5% versus 37% phosphoric acid for bonding orthodontic brackets. They concluded that the use of the 5% phosphoric acid can result in shear bond strengths comparable to those of 37% acid. Retief and Denys[7] used a variety of phosphoric acid concentrations and etching times to examine the resultant shear bond strengths to enamel. In their experiment, application of 5% phosphoric acid for 15 seconds achieved a shear bond to enamel not significantly different from application of 37% phosphoric acid for 15, 30, or 60 seconds.

Conclusions

1. Etching of enamel with 10% phosphoric acid for 30 seconds produced a shear bond not significantly different from that of etching with 37% phosphoric acid for 15 seconds.
2. When the All Bond dentin-enamel bonding system is used, the mixture of primers A and B may be applied to wet, etched enamel. In this study, the resultant bond strengths were not significantly different from those of the group that was etched with 37% acid, rinsed, and dried using the same primers.
3. With either of the acid concentrations examined, the presence of moisture was not detrimental to the ability of the All-Bond bonding system to bond to enamel. With the use of the 10% acid, the presence of wetness resulted in a mean shear bond strength higher than that found for the dry condition, although this difference was not statistically significant.

References

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